IMPEDANCE STUDIES OF Ni/Cd AND Ni/H CELLS USING THE CELL CASE AS REFERENCE ELECTRODE

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Many impedance studies have been carried out on Ni electrodes and Ni/Cd and Ni/H batteries. Some studies have been made while the cells were being discharged, others at various open circuit voltages. The impedances have been found to be strongly dependent on depths-of-discharge and/or voltage and on the procedure used to obtain the measurements. The studies have been similar qualitatively but not quantitatively. In addition to the problem of reproducibility, a second problem arises when measuring complete cells which have no reference electrode as to which portion of the impedance can be attributed to the anode and which portion to the cathode. In order for impedance to become a diagnostic tool, accurate and reproducible measurements must be made, and some way of separating the contributions of the individual electrodes must be found.

Recent studies in our laboratories using the PAR and the Solartron impedance equipment have found that consistent measurements can be made if the cells or electrodes are equilibrated at the voltage of interest. In the charged state, equilibration times required are short, on the order of a few hours or less, but the equilibration time required becomes progressively longer as the voltage is lowered. We have also found that the cell case can be used as a reference electrode during impedance measurements. The voltage of the case with respect to the electrodes is unimportant provided that it does not change appreciably during the course of the measurement. Measurements have been made with several uncycled Ni/Cd cells, one from a lot which was known to have faulty Cd electrodes and another from a lot which showed excellent cycle life and presumably had good Cd electrodes. The impedances of the Ni electrodes vs. the case were similar, while the impedance of the poor Cd electrodes vs. the case were an order of magnitude greater than that of the good Cd electrode vs. the case. A 50 AH Ni/H cell has also been investigated. After subtraction of the ohmic resistances, the sums of the impedances of the individual electrodes were very close to the impedance of the total cell. This indicates that the method is valid for examining the characteristics of the individual electrodes *in situ*.